Kelly KBL Series Brushless Motor Controller User's Manual

Devices Supported:

KBL24101	KBL36101
KBL24151	KBL36151
KBL24201	KBL36201
KBL24301	KBL36301
KBL48101	KBL72101
KBL48151	KBL72151
KBL48201	KBL72201
KBL48251	KBL72251
KBL48301	KBL72301
KBL12151H	KBL12221H

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Chapter 1 Introduction

1.1 Overview

The manual introduces Kelly BLDC motor controller features, installation and maintenance. Read the manual carefully and thoroughly before use the controller. Should you have any questions, please contact the support center of Kelly Controls, LLC.

Kelly's programmable motor controllers provide efficient, smooth and quite controls for electrical vehicles like golf cart, go-cart, electric motorcycle, fork lift, hybrid vehicle, as well as electric boat and industry motor speed control. It uses high power MOSFET, fast PWM to achieve efficiency >98% in most cases. Powerful microprocessor brings in comprehensive and precise control to the controllers. It also allows users to set parameters, conduct tests, and obtain diagnostic information quickly and easily.

Chapter 2 Main Features and Specifications

2.1 General functions

(1) Extended fault detection and protection. LED flashing for fault code.
(2) Monitoring battery voltage. Stop driving if battery voltage is too high or too low.
(3) Built-in current loop and over current protection.
(4) Controller temperature measurement and protection
(5) Current cutback at low temperature and high temperature to protect battery and controller. The current will ramp down quickly if controller temperature is higher than 90C, and shutdown at 100C. Low temperature current ramping down usually starts at 0C.
(6) The controller keeps monitoring voltage during regen. It will cut back current or stop regen if voltage is too high.
(7) Configurable to limit max reverse speed to half of max forward speed
(8) Two RS232 ports. One for configuration, the other for application.
(9) Configurable and programmable with RS-232. Software upgradeable. Windows GUI provided.
(10) Provide 5V sensor supply
(11) Reverse alarm output. Recirculation diodes provided.
(12) Motor temperature detection and protection
(13) 3 hall position sensor inputs. Open collector. The controller provides pull up.
(14) 3 switch inputs. Close to ground to activate. Default to throttle switch, brake switch and reverse switch.
(15) 3 analog inputs, 0-5V. Default to throttle input, brake input and motor temperature input
(16) Optional CAN bus.

Caution! Regeneration has braking effect, but can't replace mechanical brake. Mechanical brake is required to stop your vehicle. Regen isn't a safety feature! Controller may stop regen to protect itself (not you!).

2.2 Features

•Intelligence with powerful microprocessor.
•Synchronos rectification, ultra low drop, fast PWM to achieve very high efficiency.
•Current limit and torque control.
•Low EMC.
•Battery protection: current cut back, shutdown and warning at low battery.
•Thermal enhanced rugged aluminum housing. Rugged connectors.
•Thermal protection: Current cut back on low temperature and high temperature to protect battery and controller.
•Compatible with 60-degree or 120-degree hall position sensor.
•Support any number of poles.
•Up to 60000 electric RPM. (electric RPM = mechanical RPM * motor poles)
•High pedal protection: Disable operation if power up with non-zero throttle.

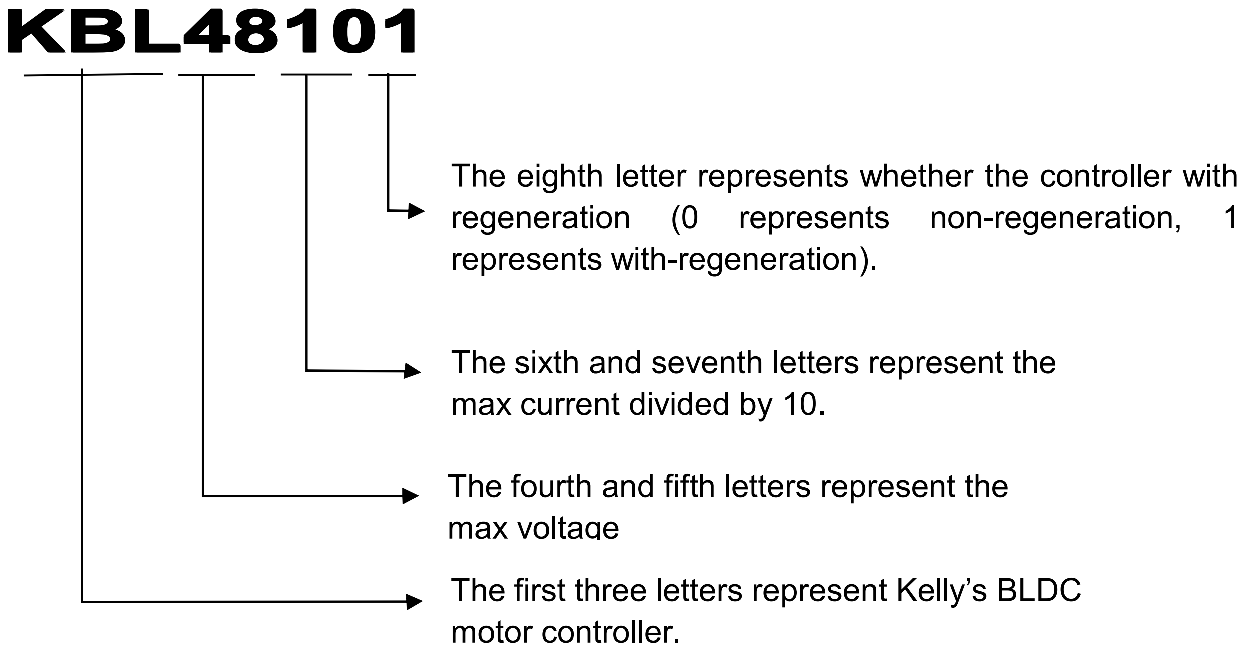
•Brake switch is used to start regen.
•0-5V brake signal is used to command regen current.

2.3 Specifications

- Frequency of Operation: 16.6kHz.
- Standby Current: less than 3 mA.
- Supply Voltage, PWR, 18V to 90V.
- Supply Current, PWR, 150mA.
- Operating Voltage, B+, 18V to 1.25*Norminal.
- Analog Brake and Throttle Input: 0-5 Volts.
- Reverse alarm: <150mA.
- Full Power Operating Temperature Range: 0C to 50C (controller case temperature).
- Operating Temperature Range: -30C to 90C, 100C shutdown (controller case temperature).
- Armature Current Limit, 1 minute: 100A / 150A / 200A / 250A / 300A .
- Armature Current Limit, Continuous: 60A / 90A / 120A / 150A / 180A .

2.4 Model

The naming regulation of the Kelly BLDC motor controller model:



Chapter 3 Wiring and Installation

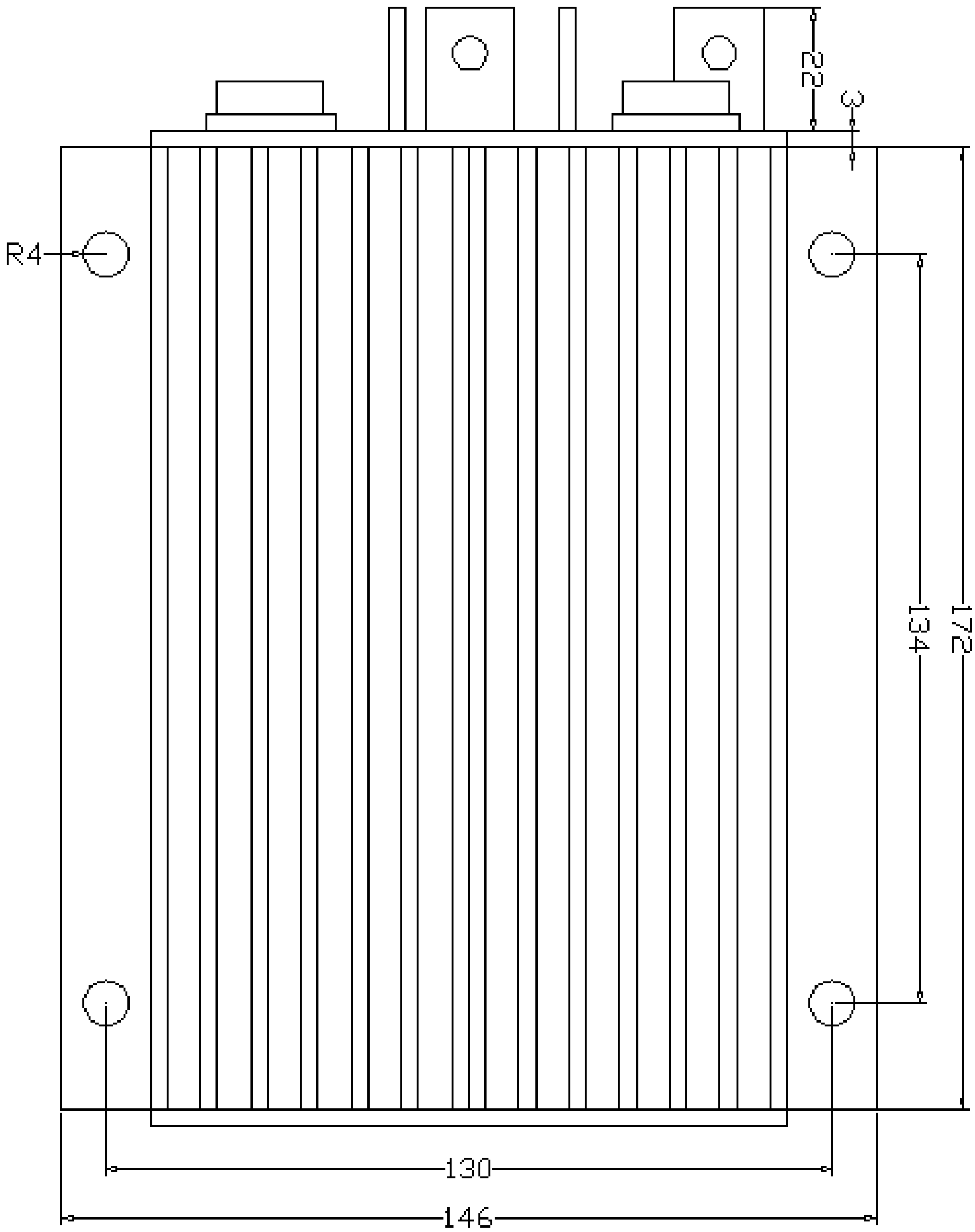
3.1 Mounting the Controller

The controller can be oriented in any position as clean and dry as possible, or shield with a cover to protect it from water and contaminants.

To ensure full rated output power, the controller should be fastened to a clean, flat metal surface with four screws. Applying silicon gel or other thermal conductive material to contact surface will enhance thermal performance.

Sufficient heat sink and airflow are required for high power application.

The case outline and mounting hole dimensions are shown in Figure 1.



Tall: 62 millimeters

Figure 1: mounting hole dimensions (dimensions in millimeters)

3.2 Connections

3.2.1 Front Panel of BLDC Motor Controller:

Five metal bars and two plugs (J1, J2) are provided for connections to the battery, motor and control signals in the front of the controller shown as Figure 2.

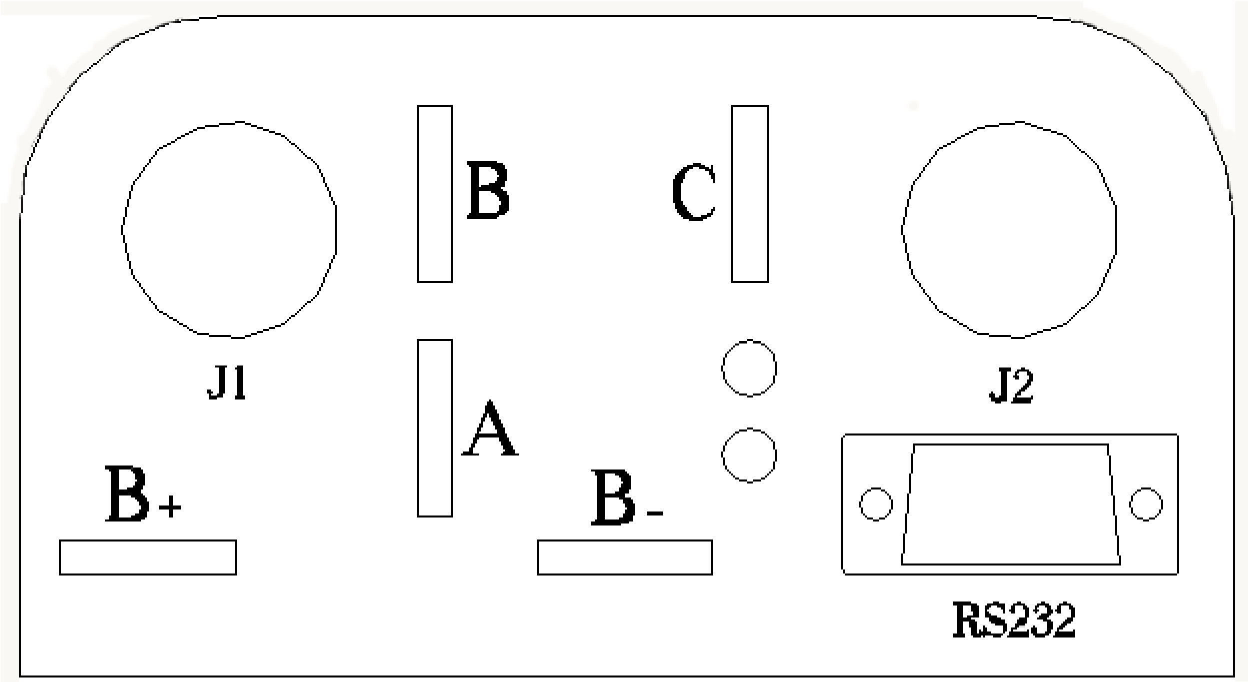


Figure 2: Front panel of BLDC motor controller

B+: battery positive
B-: battery negative
A: Output U/1/A phase
B: Output V/2/B phase
C: Output W/3/C phase

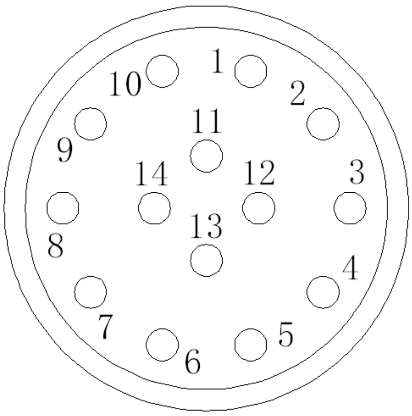


Figure 3: The connecting diagram of **J1** and **J2**

J1 Pin Definition

1- **Red LED: Fault code**
2- **Reserved:**
3- **Reserved:**
4- **Alarm: To drive reverse beeper**
5- **GND: Signal return**
6- **Green LED: Running indication**
7- **GND: Signal return**
8- **RS232 receiver**
9- **RS232 transmitter**
10- **CAN bus high**
11- **CAN bus low**
12- **Reserved**
13- **GND: Signal return, or power supply ground**
14- **PWR: Controller power supply**

J2 Pin Definition

1- PWR: Controller power supply
2- GND: Signal return, or power supply ground
3- GND: Signal return
4- Motor temperature input.
5- Throttle analog input, 0-5V
6- Brake analog input, 0-5V
7- 5V: 5V supply output
8- Throttle switch input
9- Reverse switch input
10- Brake switch input
11- Hall phase C
12- Hall phase B
13- Hall phase A
14- GND: Signal return

Notes:

1. **All GND pins are internally connected. GND is internally connected to B-**
2. **Two PWR pins, J1-14 and J2-1, are internally connected. It's recommended to use J1-14 to supply peripherals like alarm and meters. Twist peripheral wires with PWR is the best for EMC. Recirculation diodes are provide in the controller for alarm and meter drivers.**
3. **Switch to ground is active. Open switch is inactive**

Caution: Make sure all connections are correct before apply power. Otherwise it may damage the controller! Please securely wire B- before applying power. Never put contactor or break on B-. Don't connect GND to B-.

3.2.2 Standard Wiring of BLDC Motor Controller

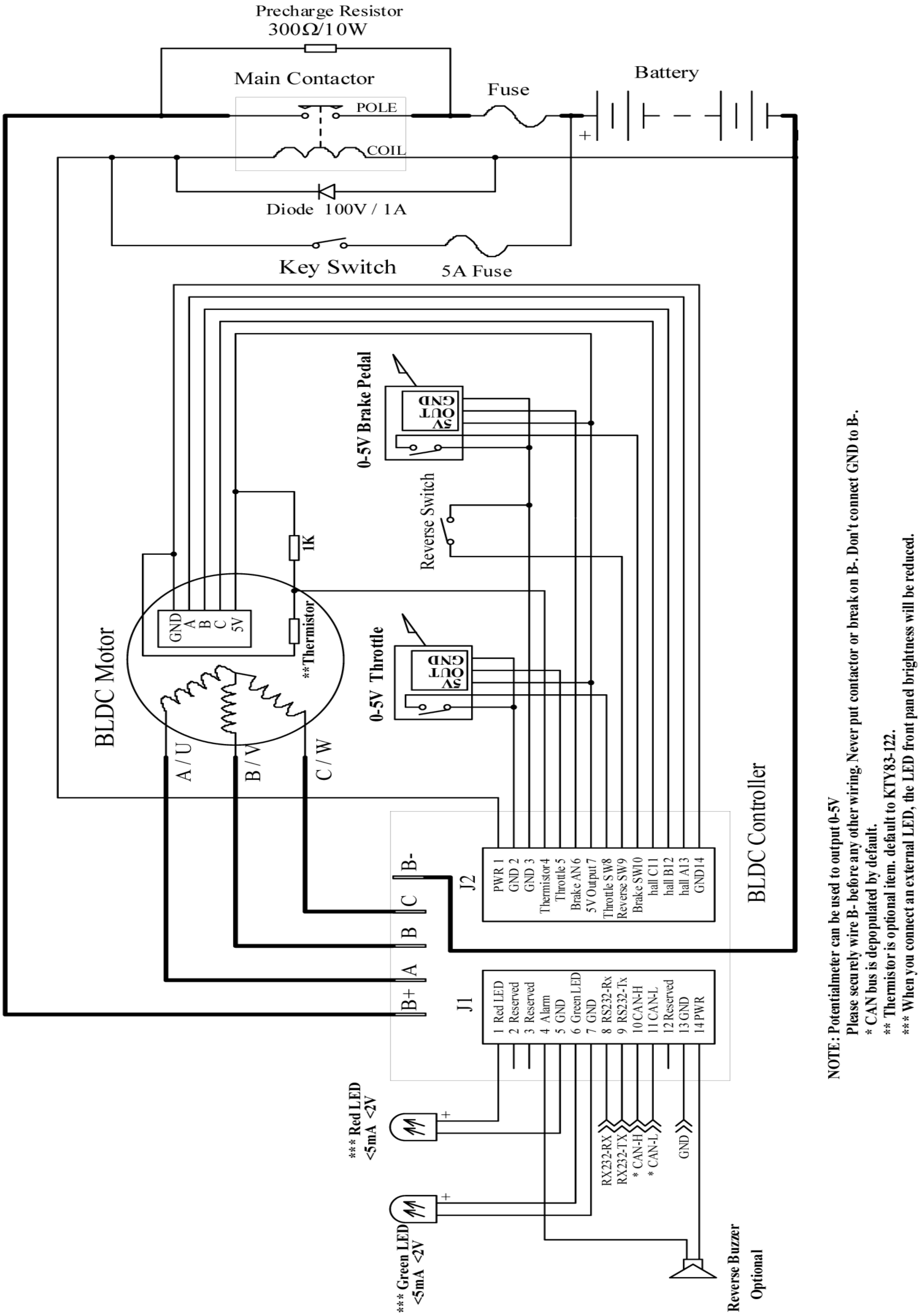


Figure 4: BLDC controller standard wiring

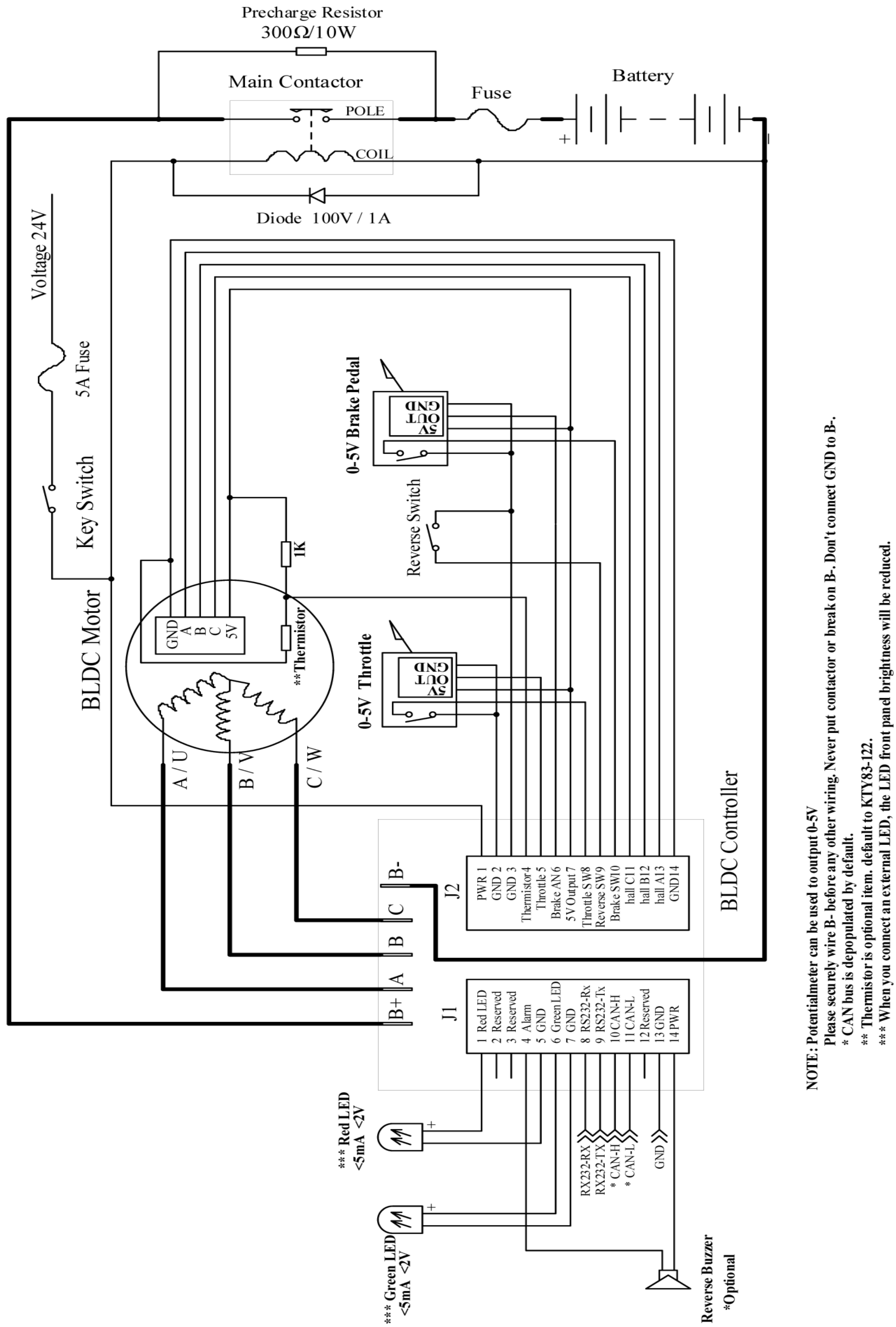


Figure 5: BLDC controller preferred wiring

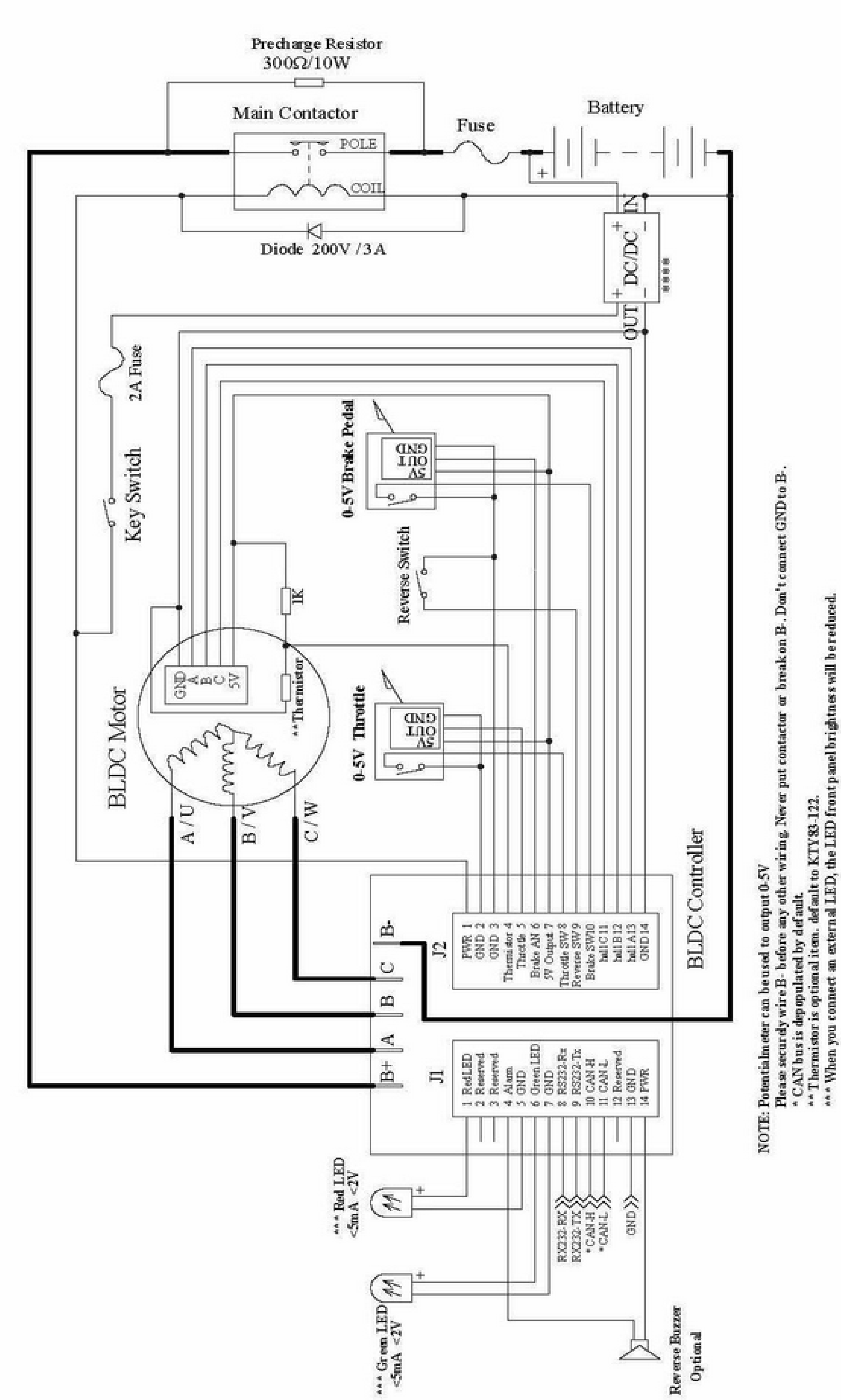


Figure 6: The standard wiring of KBL12151H/KBL12221H

3.2.3 Communication Port

A RS232 port of controller is provided to communicate with host computer for calibration and configuration.

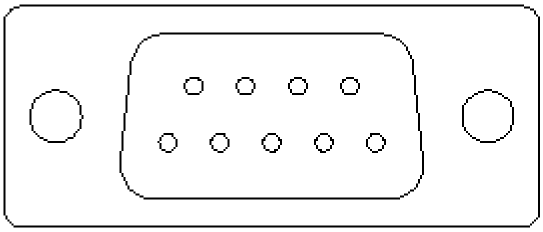


Figure 6: standard RS232 interface

3.3 Installation Check list

Before operating the vehicle, complete the following checkout procedure. Use LED code as a reference. The LED codes are listed in Table 1.

Caution:
- Put the vehicle up on blocks to get the drive wheels off the ground before beginning these tests.
- Do not allow anyone to stand directly in front of or behind the vehicle during the checkout.
- Make sure the PWR switch and the brake is off
- Use well-insulated tools.

- Make sure the wire is connected correctly
- Turn the PWR switch on. The LED should blink, then keeps on when the controller operates normally. If this does not happen, check continuity of the PWR and controller ground.
- The fault code will be detected automatically at restart.
- With the brake switch open, select a direction and operate the throttle. The motor should spin in the selected direction. Please verify wiring and voltage if it doesn't. Also check fuse. The motor should run faster with increasing throttle. If not, refer to Table 1 LED code, and correct the fault according to the code.
- Take the vehicle off the blocks and drive it in a clear area. It should have smooth acceleration and good top speed.

Chapter 4 Maintenance

There are no user-serviceable parts inside the controllers. Do not attempt to open the controller. Or you will damage it. However, clearing the controller exterior periodically should be necessary.

The controller is inherently a high power device. When working with any battery powered vehicle, proper safety precautions should be taken. These include, but are not limited to: proper training, wearing eye protection, avoiding loose clothing and jewelry, and using insulated wrenches.

4.1 Cleaning

Although the controller requires virtually no maintenance after properly installation, the following minor maintenance is recommended in certain applications.

- Remove power by disconnecting the battery.
- Discharge the capacitors in the controller by connecting a load (such as a contactor coil or a horn) across the controller's B+ and B- terminals.
- Remove any dirt or corrosion from the bus bar area. The controller should be wiped with a moist rag. Be sure it is dry before reconnecting the battery.
- Make sure the connections to the bus bars are tight. Use two wrenches for this task in order to avoid stressing the bus bars; the wrenches should be well insulated.

4.2 Configuration

You can configure the controller with a host computer through RS232.

- Use straight RS232 cable connecting the 9pin connector on face penal to a host computer Provide 18V to 90V to PWR (either J2 pin1 or J1 pin14). Wire power supply ground to any GND pin.
- Do not connect B+, throttle and so on. The controller may display fault code, but it doesn't affect programming or configuration.

Table 1: LED CODES

Green LED Codes

LED Code	Explanation	Solution
Green Off	No power or not operating	1. Check if all wires are correct. 2. Check fuse and power supply.
Green On	Normal operation	That's great! You got solution!
Green and Red LED Keep On		1. Software is upgrading. 2. The controller is damaged. Please contact Kelly for warrantee.

Red LED Codes

LED Code		Explanation	Solution
1,2	¤ ¤¤	Over voltage error	1. Battery voltage is higher than max operating voltage of the controller. Please check the battery voltage and configuration. 2. Over voltage at regeneration. Controller will cut back or stop regeneration.
1,3	¤ ¤¤¤	Low voltage error	1. The controller will attempt to clear the fault code automatically after 5 second if battery return to normal. 2. Check the battery voltage. 3. Charge battery if necessary.
1,4	¤ ¤¤¤¤	Over temperature warning	1. The controller temperature is over 90ºC. The controller will cut back current in the case. Stop or reduce output to ensure the temperature fall. 2. Improve heat sink or airflow
2,1	¤¤ ¤	Motor RPM over low	1. After 2 seconds which controller start to output, motor rotate speed doesn't reach 25 electric RPM, the controller will limit output current. When motor rotate speed beyond 25 electric RPM, output current won't be limited.
2,2	¤¤ ¤¤	Internal voltage fault	1. Check if the B+ and PWR voltage are correct, refer to B- or GND. 2. Please check load on 5V supply. 3. The controller is damaged. Please contact Kelly for warrantee.
2,3	¤¤ ¤¤¤	Over temperature	1. The controller temperature is over 100ºC. Controller stops driving in order to protect itself. 2. Stop driving and wait for temperature fall. The controller will restart if temperature drops below 80ºC.

2,4	¤¤ ¤¤¤¤	Throttle error at power up	1. The throttle signal is higher than configured dead zone at power-on 2. The fault will disappear if restart or release throttle.
3,1	¤¤¤ ¤	Frequent reset	1. The controller will stop driving after detect too many resets. 2. mostly because of overcurrent protection 3. Restart will clear the error. 4. Please contact Kelly if it happens repeatedly
3,2	¤¤¤ ¤¤	Internal reset	Reset caused by over current or so. It is normal if occurring occasionally.
3,4	¤¤¤ ¤¤¤¤	Throttle isn't zero when try to change direction	The controller won't change drive direction if throttle isn't zero. Also it won't change direction at high speed. The controller will wait throttle and speed close to zero before change direction.
4,1	¤¤¤¤ ¤	Over voltage at startup or regeneration	The controller won't drive motor if detect overvoltage at power up. It will cut back regen current or stop regen if detect overvoltage during regen. You may set overvoltage threshold with GUI. The max threshold is about 1.25 times of controller rated voltage. I.e. you may set threshold lower than 60V for 48V controller.
4, 2	¤¤¤¤ ¤¤	Hall sensor signal error	120 degree hall motor produce the coding belonging to 60 degree hall motor, or 60 degree hall motor produce the coding belonging to 120 degree. Needing user to set the hall angle to correct type through calibration software.
4, 3	¤¤¤¤ ¤¤¤	Motor over temperature	1.The motor temperature sensor beyond the setting temperature, the motor will stop outputing and waiting motor temperature to drop to original temperature, then restart. 2.Can change the temperature through calibration software.
The LED flashes once at power on, then keeps on for normal operation. "1, 2" means it flashed once, then flashes twice after 1 second. The time between two flashes is 0.5 second. The pause time between one error code and another error code is 2 second.			

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